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SHORT COMMUNICATION

A key to *Ptilotus* (Amaranthaceae) in Western Australia

Ptilotus R.Br. (Amaranthaceae) is a genus of approximately 120 species, all of which are native to continental Australia and with most of the diversity occurring in Western Australia (Hammer *et al.* 2015). The key presented here for 96 Western Australian taxa is a continuation of on-going work to produce an Australia-wide key for *Ptilotus* by the authors, which was originally presented on *KeyBase* (available at http://keybase.rbg.vic.gov.au/keys/show/6609, accessed 16 August 2018; previously mentioned in Hammer & Davis 2018). The Western Australian key was constructed by examining specimens lodged at the Western Australian Herbarium (PERTH) and includes all of the 93 named species now recognised (i.e. excluding *P. petiolatus* Farmar and including *P. unguiculatus* T.Hammer; see Hammer 2018). The subspecies of *P. polakii* F.Muell., *P. sericostachyus* (Nees) F.Muell. and *P. stirlingii* (Lindl.) F.Muell. are also included in the key. However, the infraspecific taxa of *P. drummondii* (Moq.) F.Muell., *P. obovatus* (Gaudich.) F.Muell. and *P. schwartzii* (F.Muell.) Tate, currently recognised on the plant census for Western Australia, were excluded pending on-going studies into their taxonomic status. Also excluded from the key are the phrase names *P.* sp. Beaufort River (G.J. Keighery 16554), *P.* sp. Mt Narryer (A.S. George 17484) and *P.* sp. Porongorup (R. Davis 10805), which are in need of further study.

As new species are discovered (e.g. Davis & Hammer 2018; Hammer & Davis 2018) and new evidence is found to change existing taxonomic concepts (e.g. Hammer *et al.* 2018a, 2018b), there will no doubt be future revisions needed to this Western Australian key. An interactive version of it is available on *KeyBase* (http://keybase.rbg.vic.gov.au/keys/show/6627, accessed 8 August 2018) as part of the *Flowering plants of Western Australia* project.

Notes on distinctive characters

We use 'sepal' in this key instead of the traditionally used 'tepal' to describe the uniseriate perianth of *Ptilotus* (for more information, see Hammer 2018). All species of *Ptilotus* have five sepals, with two outer enclosing three inner in bud. Inner and outer sepals may differ conspicuously in morphology, or may be almost indistinguishable in fully open flowers. The term 'clawed' refers to the base of the sepal being conspicuously narrower than the dilated apex. Enclosing the base of the solitary flower are two opposite bracteoles (i.e. the prophylls), which in *Ptilotus* are membranous and can be translucent or opaque and hairy or glabrous. At the base of the bracteoles is a single bract, which is alternate to the two bracteoles (for more information on this flowering arrangement, see Acosta *et al.* 2009). The morphology of the bract and the bracteoles is often diagnostic.

Early steps in the key include the placement of the style on the ovary summit, and the number of fertile stamens. The style is usually either clearly central or clearly excentric (see Figure 4 in Hammer *et al.* 2015); where this is ambiguous or where we have found infraspecific variation, we have included the species in both sections of the key. The androecium of *Ptilotus* is 5-merous, usually comprising a distinct androecial cup with stamens or staminodes opposite the sepals (Figure 1A, B). Commonly, one or more stamens are infertile and reduced to staminodes. The number of fertile stamens is consistent within species and across geographic ranges (e.g. Hammer *et al.* 2018b), with the exception of *P. manglesii*

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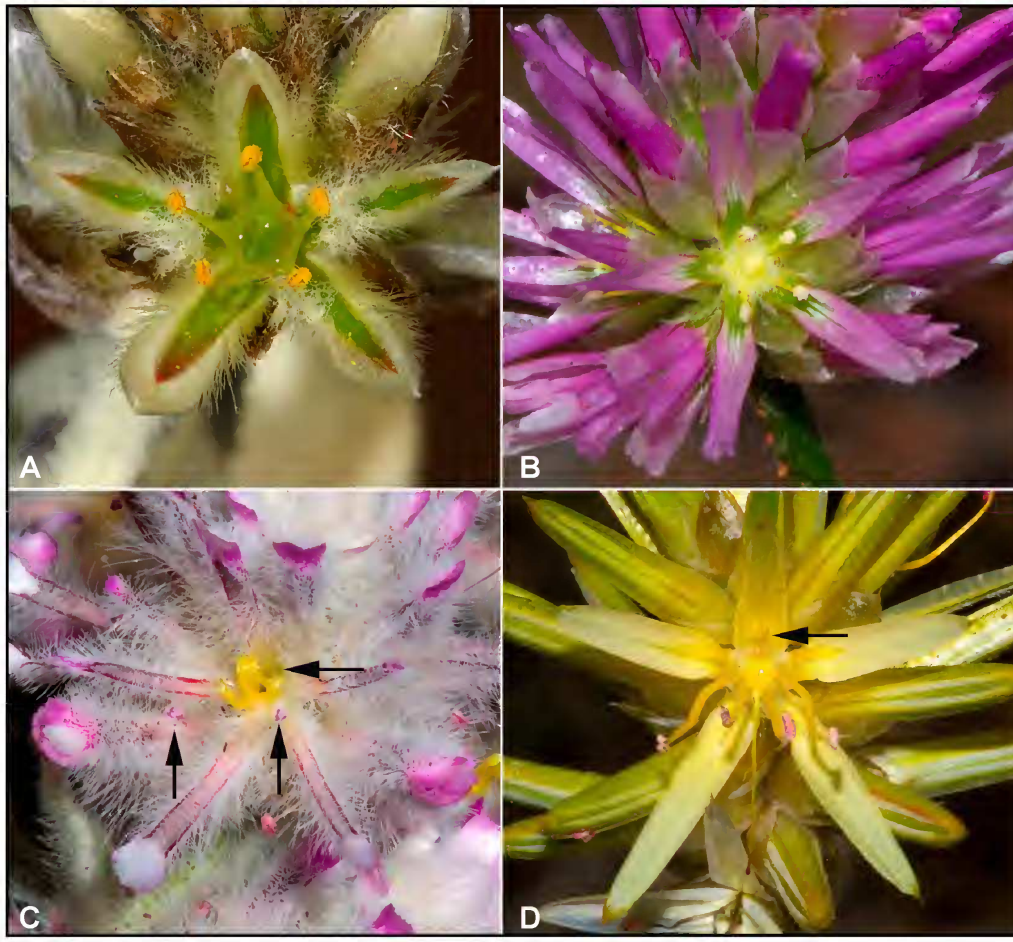

Figure 1. Morphology of the androecium in *Ptilotus*. A – five fertile stamens opposite sepals in *P. luteolus* (Benl & H.Eichler) R.W.Davis; B – five fertile stamens opposite sepals in *P. grandiflorus* F.Muell.; C – reduced stamen number to two with three showy staminodes in *P. appendiculatus* Benl; D – reduced stamen number to four with an inconspicuous staminode in *P. gaudichaudii* (Steud.) J.M.Black. Horizontal arrows indicate staminodes (C, D) and vertical arrows indicate fertile stamens (C). Photographs by R. Davis (A) and T. Hammer (B–D).

(Lindl.) F.Muell., which may have three to five fertile stamens in different flowers on an individual plant. Infertile stamens (staminodes) may be showy (sometimes flattened and coloured; Figure 1C) or may comprise a reduced filament that appears as an inconspicuous appendage on the staminal cup (Figure 1D). In some species a staminode may be so reduced that it appears as just a minute projection on the staminal cup or, rarely, may appear completely absent. In addition, some species have small appendages (previously called 'pseudostaminodes') that project from the staminal cup and alternate with the stamens or staminodes.

Many species of *Ptilotus* are gynodioecious, i.e. populations comprise a mix of male-sterile (i.e. functionally female) and bisexual plants (Stewart & Barlow 1972; Hammer *et al.* 2018a; Figure 2). Bisexual plants have a fully developed androecium comprising one to five fertile stamens and up to four staminodes as described above. In male-sterile plants, all of the fertile stamens fail to fully form, leaving reduced appendages with clearly non-functional anthers (Figure 2B). While gynodioecy is common in the genus, it has not been adequately surveyed between and within species. In some species

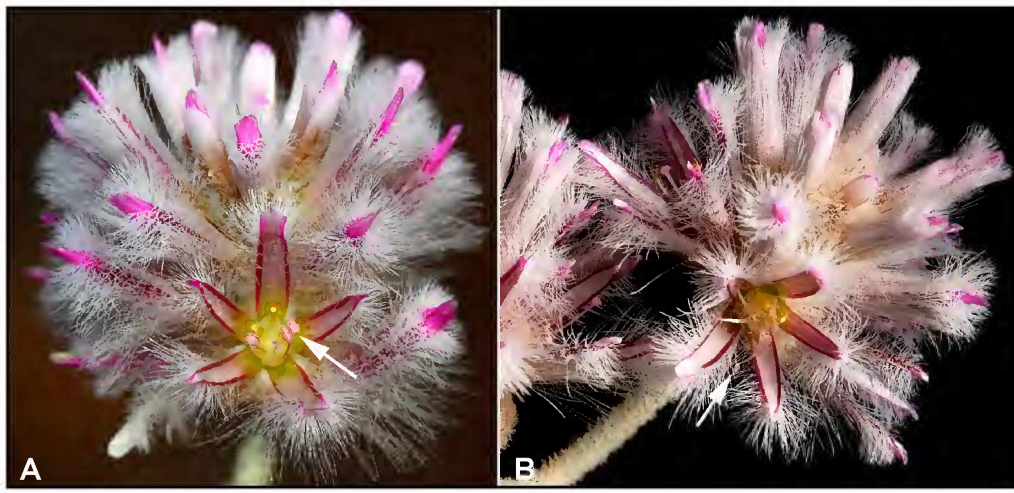

Figure 2. Variation of stamens in the gynodioecious *P. obovatus*, showing flowers of a bisexual individual on the left and a female individual on the right. Arrows indicate fertile (A) and poorly-developed (B) anthers. Photographs by R. Davis (A) and K. Thiele (B).

(e.g. *P. obovatus* and *P. schwartzii*) the ratio of male-sterile to bisexual plants may be very high; in others, occasional male-sterile individuals may be found in populations that are mostly bisexual (e.g. *P. exaltatus* Nees; Hammer *et al.* 2018a). Male-sterile individuals can be identified using this key, but care should be taken in couplet 3 to discriminate stamens (with poorly developed anthers) from staminodes (which lack anthers). Stamens with anthers in such individuals are counted as fertile in this couplet, despite being functionally sterile. One species (*P. crispus* Benl) is truly dioecious, with all individuals either female and lacking an androecium, or male with the ovary reduced and lacking a style.

Indumentum in all species comprises multi-cellular hairs, ranging from simple to branching, i.e. verticillate or dendritic (see Hammer *et al.* 2015, 2017 for discussions and figures). Simple hairs are described as nodose when the nodes between hairs are swollen and septate when they are not. Verticillate hairs have distinct whorls of side-branches at the nodes; in dendritic hairs, the side-branches do not form distinct whorls.

Key to *Ptilotus* in Western Australia

Taxa marked with an asterisk appear more than once in the key.

1. Sepals < 1.6 mm long; flowers unisexual, the males lacking styles, the females lacking sterile stamens ..... **P. crispus**

1: Sepals 2–50 mm long; flowers bisexual, or functionally female with sterile stamens

2. Style excentrically placed on the ovary summit

3. Fertile stamens 1 or 2

4. Ovary glabrous

5. Stems herbaceous

6. Fertile stamen 1 ..... **P. alexandri**

6: Fertile stamens 2

7. Adaxial surface of inner sepals with a basal tuft of hairs

8. Leaves thick, semi-succulent to succulent; flowers green; sepals with short, appressed hairs on abaxial surface ..... **P. chortophytus**

8: Leaves flat, not semi-succulent or succulent; flowers pink to purple; sepals with long, spreading hairs on abaxial surface

9. Plants decumbent; bracts 1.8–4.5 mm long; bracteoles 3–5 mm long ..... **P. stirlingii** subsp. **stirlingii**

9: Plants prostrate; bracts 5.3–6 mm long; bracteoles 5.4–6.3 mm long ..... **P. stirlingii** subsp. **australis**

7: Adaxial surface of inner sepals ± glabrous

10. Staminodes conspicuous, *c.* 2 mm long ..... **P. halophilus**

10: Staminodes minute or absent

11. Bracts 6.5–7 mm long ..... **P. sericostachyus** subsp. **roseus**

11: Bracts 4–5.7 mm long ..... **P. sericostachyus** subsp. **sericostachyus**

5: Stems woody or basally woody

12. Leaves petiolate

13. Glabrous portion of outer sepal apex 3–5 mm long; bracts ± equal in length to bracteoles; style 6–10 mm long ..... **P. polakii** subsp. **polakii**

13: Glabrous portion of outer sepal apex 1–2 mm long; bracts shorter than bracteoles; style 4–5.5 mm long ..... **P. polakii** subsp. **juxtus**

12. Leaves sessile or subsessile

14. Stems erect or ascending; leaves not crowded at the base of the stem ..... **P. beardii**

14: Stems prostrate, mat-forming; leaves crowded at the base of the stem

15. Sepals < 7 mm long, apex not rounded (presumed extinct) ..... **P. caespitulosus**

15: Sepals > 8 mm long, apex rounded ..... **P. fasciculatus**

4: Ovary hairy

16. Stems herbaceous

17. Inner sepals with a prominent basal tuft of hairs inside

18. Leaves with persistent verticillate hairs on adaxial surface to 2 mm long ..... **P. andersonii**

18: Leaves glabrous or glabrescent

19. Flowers pink; sepal apex rounded and dilated; lower portion of sepals densely hairy ..... **P. chippendalei**

19: Flowers creamish green; sepal apex acute, not dilated; lower portion of sepals glabrous ..... **P. seminudus**

17: Inner sepals without basal tuft of hairs inside

20. Bracts longer than bracteoles ..... **P. blackii**

20: Bracts shorter than bracteoles

21. Leaves with persistent villous indumentum ..... **P. appendiculatus**

21: Leaves mostly glabrous ..... **P. axillaris**

16: Stems woody or basally woody

22. Bracts shorter than bracteoles

23. Stems divaricately branching ..... **P. lazaridis**

23: Stems with no pattern of branching, i.e. not divaricate

24. Leaves > 3 mm wide, not in fascicles

25. Leaves with persistent verticillate hairs ..... **P. kenneallyanus***

25: Leaves glabrous ..... **P. stipitatus**

24: Leaves < 1.6 mm wide, in fascicles

26. Stems hairy; sepals 15–19 mm long ..... **P. daphne**

26: Stems glabrous; sepals 11–13 mm long ..... **P. rigidus**

22: Bracts longer than bracteoles

27. Leaves glabrous or glabrescent, incurved, semi-succulent ..... **P. yapukaratja**

27: Leaves with persistent verticillate hairs, not as above ..... **P. kenneallyanus***

3: Fertile stamens 3–5

28. Ovary glabrous

29. Stems prostrate or decumbent

30. Annuals

31. Outer sepals at least 10 mm longer than inner sepals ..... **P. crosslandii**

31: Outer and inner sepals similar in size

32. Sepals glabrous, apex truncate-serrate ..... **P. grandiflorus***

32: Sepals with straight hairs on abaxial surface, apex acute ..... **P. procumbens**

30: Perennials

33. One stamen modified into a conspicuous staminode to 17 mm long ..... **P. declinatus**

33: Stamens all fertile or staminodes short and inconspicuous

34. Sepals with hairs exceeding the apex ..... **P. symonii**

34: Sepals with hairs not exceeding the apex

35. Inflorescences becoming long-cylindrical; basal leaves distinctly spathulate ..... **P. spathulatus**

35: Inflorescences mostly ovoid; basal leaves oblanceolate

36. Plants single-stemmed ..... **P. clivicola**

36: Plants multi-stemmed

37. Sepals white to green; bracts prominently sickle-shaped ..... **P. falcatus**

37: Sepals pink; bracts not sickle-shaped ..... **P. manglesii***

29: Stems erect

38. Leaves with hairs obscuring surface

39. Staminodes absent or obscure ..... **P. eriotrichus**

39: Staminodes prominent and coloured

40. Staminodes pink; sepals 12–20 mm long ..... **P. sessilifolius**

40: Staminodes yellow; sepals 6.5–9.5 mm long..... **P. incanus**

38: Leaves glabrous or with sparse hairs not obscuring the surface

41. Stems woody or basally woody, divaricately branching ..... **P. divaricatus**

41: Stems herbaceous, not divaricately branching

42. Small herb < 8 cm tall; basal rosette of spathulate leaves ..... **P. pyramidatus**

42: Herbs > 8 cm tall; leaves not as above

43. Sepals with hairs restricted to midrib of abaxial surface ..... **P. gaudichaudii***

43: Sepals with hairs not restricted to midrib of abaxial surface

44. Bracts opaque; fertile stamens 3

45. Flowers purple to pink; sepals gaping widely at anthesis, straight; ovary obscured by a plug of woolly hairs at the base of the sepals ..... **P. exaltatus***

45: Flowers creamish green, rarely with a pale pink flush; sepals not gaping widely at anthesis, ± falcately down-curved; ovary not obscured, the hairs at the base of the sepals ± erect, not forming a woolly plug..... **P. nobilis***

44: Bracts translucent; fertile stamens 4 or 5

46. Sepal abaxial surface glabrous apart from basal hairs; flowers pink; fertile stamens 5 ..... **P. grandiflorus***

46: Sepal abaxial surface hairy apart from apex; flowers cream to green; fertile stamens 4

47. Inflorescences 30–60 mm wide; flowers not opening broadly, radially symmetric; old flowers not appressed to rachis..... **P. macrocephalus***

47: Inflorescences 18–28 mm wide; flowers opening broadly, bilaterally symmetric; old flowers appressed to rachis..... **P. polystachyus***

28: Ovary hairy

48. Perennials

49. Inflorescences interrupted..... **P. distans**

49: Inflorescences not interrupted

50. Stems prostrate or decumbent

51. Bracts dark, opaque; sepal apex glabrous for 4–8 mm, truncate-serrate..... **P. manglesii***

51: Bracts translucent; sepal apex hairy, acute ..... **P. holosericeus**

50: Stems erect

52. Stems woody or basally woody (when young); sepals without densely woolly indumentum on the adaxial surface; staminodes 2, flattened, yellow and showy ..... **P. obovatus**

52: Stems herbaceous; sepals with densely woolly indumentum on the adaxial surface; staminodes 2, filiform, not showy, obscured by woolly sepal hairs..... **P. exaltatus***

48: Annuals

53. Inner sepals adaxially glabrous

54. Outer sepals much longer than inner ..... **P. trichocephalus**

54: Outer and inner sepals subequal

55. Sepals with hairs restricted to midrib on abaxial surface

56. Sepals 10–15 mm long; anthers > 0.9 mm long ..... **P. gaudichaudii***

56: Sepals 6–9 mm long; anthers < 0.6 mm long ..... **P. eremita**

55: Sepals with hairs not restricted to midrib on abaxial surface

57. Sepal apex truncate-serrate; flowers orange to yellow ..... **P. carlsonii**

57: Sepal apex acute; flowers creamish green, sometimes with pale pinkish tinge

58. Stems prostrate, sprawling; sepals < 6 mm long ..... **P. aervoides***

58: Stems erect or ascending; sepals > 8 mm long

59. Ovary with a distinct coma of hairs ..... **P. fusiformis**

59: Ovary without a distinct coma of hairs

60. Inflorescences 30–60 mm wide; flowers not opening broadly, radially symmetric; old flowers not appressed to rachis ..... **P. macrocephalus***

60: Inflorescences 18–28 mm wide; flowers opening broadly, bilaterally symmetric; old flowers appressed to rachis

61. Pedicel (i.e. the stalk attaching the bract and flowering unit to the rachis) after abscission squat, with a prominent disc at apex; ovary gibbous; staminal cup with sparse, short hairs ..... **P. polystachyus***

61: Pedicel (i.e. the stalk attaching the bract and flowering unit to the rachis) after abscission slender, with a reduced disc at apex; ovary not gibbous; staminal cup with copious, long, silky hairs ..... **P. giganteus**

53: Inner sepals adaxially hairy or with row of hairs on inwardly folding margins

62. Inflorescences interrupted ..... **P. tetrandrus**

62: Inflorescences not interrupted

63. Bracts glabrous, translucent

64. Flowers green; sepals > 15 mm long; staminode inconspicuous ..... **P. macrocephalus***

64: Flowers pink; sepals < 10 mm long; staminode conspicuous

65. Sepals > 6 mm long; staminode > 3 mm long; anthers > 0.6 mm long ..... **P. helipteroides***

65: Sepals < 5.5 mm long; staminode < 2.6 mm long; anthers < 0.6 mm long ..... **P. actinocladus**

63: Bracts hairy, opaque

66. Sepals < 10 mm long ..... **P. carinatus**

66: Sepals > 16 mm long

67. Flowers purple to pink; sepals gaping widely at anthesis, straight; ovary obscured by a plug of woolly hairs at the base of the sepals ..... **P. exaltatus***

67: Flowers creamish green, rarely with pale pink flush; sepals not gaping widely at anthesis, ± falcately down-curved; ovary not obscured, the hairs at the base of the sepals ± erect, not forming a woolly plug..... **P. nobilis***

2: Style centrally placed on the ovary summit

68. Leaves persistently hairy

69. Stems herbaceous

70. Bracts and bracteoles longer than sepals..... **P. decipiens***

70: Bracts and bracteoles shorter than sepals

71. Inflorescences nodding; flowers creamish green

72. Bracteoles glabrous; leaves to 45 mm long with velvety indumentum..... **P. gardneri**

72: Bracteoles pilose; leaves to 90 mm long with villous indumentum..... **P. clementii**

71: Inflorescences not nodding; flowers pink..... **P. helipteroides***

69: Stems woody or basally woody

73. Ovary glabrous

74. Abaxial sepal hairs woolly, clearly exceeding apex..... **P. albidus**

74: Abaxial sepal hairs not woolly, not exceeding apex

75. Leaves > 30 mm wide

76. Sepals and staminal filaments pink; inflorescences > 30 mm wide..... **P. rotundifolius**

76: Sepals creamish green; staminal filaments white; inflorescences < 21 mm wide..... **P. marduguru**

75: Leaves < 20 mm wide

77. Leaves narrowly oblanceolate to narrowly elliptical..... **P. wilsonii**

77: Leaves ovate to spathulate

78. Stems and leaves with yellow, villous indumentum of long, branching hairs..... **P. luteolus**

78: Stems and leaves with grey-green, tomentose indumentum of short, branching hairs..... **P. astrolasius**

73: Ovary hairy

79. Stamens longer than sepals..... **P. helichrysoides**

79: Stamens shorter than sepals

80. Flowers interrupted, in solitary, terminal spikes..... **P. royceanus**

80: Flowers densely arranged, in terminal panicles..... **P. mollis**

68: Leaves glabrous or glabrescent, or mature plants leafless

81. Stems erect

82. Staminal cup appendages present

83. Bracteoles longer than sepals..... **P. latifolius**

83: Bracteoles shorter than sepals

84. Sepals green; inflorescences > 24 mm wide..... **P. benlii**

84: Sepals pink to pale pink or whitish; inflorescences < 20 mm wide

85. Stems leafless at maturity ..... **P. aphyllus**

85: Stems with leaves at maturity

86. Erect, slender herbs; taproot fleshy; inflorescences cylindrical ..... **P. calostachyus**

86: Rounded herbs or subshrubs (stems basally woody); taproot woody; inflorescences globular to ovoid

87. Stems becoming woody, branching; leaves narrow-linear, sparse ..... **P. schwartzii**

87: Stems herbaceous, simple; leaves lanceolate to spathulate, basally crowded..... **P. drummondii***

82: Staminal cup appendages absent

88. Inner sepals glabrous on adaxial surface

89. Stems herbaceous

90. Sepal abaxial surface glabrescent, hairs concentrated at apex..... **P. decalvatus**

90: Sepal abaxial surface with persistent hairs at base or throughout

91. Sepals woolly at base of abaxial surface, glabrous at apex..... **P. gomphrenoides***

91: Sepals villous throughout length of abaxial surface..... **P. lanatus**

89: Stems woody

92. Style ± straight..... **P. arthrolasius**

92: Style conspicuously sigmoid ..... **P. chrysocomus**

88: Inner sepals with hairs on adaxial surface or on inner margins

93. Inner sepals clawed

94. Inflorescence units in corymb- or umbel-like clusters.....

95. Inflorescence units hemispherical to ovoid, in loose corymbs..... **P. corymbosus**

95: Inflorescence units obovoid, in dense umbel-like clusters..... **P. johnstonianus**

94: Flowers not clustered as above

96. Staminal filaments narrowly ligulate, dilated into a disc under anthers..... **P. conicus**

96: Staminal filaments not as above

97. Bracts and bracteoles with an awn-like apex

98. Staminal cup with divergent, forked appendages..... **P. capitatus**

98: Staminal cup without appendages..... **P. spicatus**

97: Bracts and bracteoles without awn-like apex ..... **P. mitchellii***

93: Inner sepals not clawed

99. Abaxial sepal hairs exceeding sepal apex

100. Bracteoles as long as sepals ..... **P. villosiflorus**

100: Bracteoles at most half the length of sepals..... **P. subspinescens**

99: Abaxial sepal hairs not exceeding sepal apex

101. Inflorescences nodding; staminal cup long and tube-like, 8–11 mm long.... **P. auriculifolius**

101: Inflorescences not nodding; staminal cup short, < 1.5 mm long

102. Bract apex aristate ..... **P. decipiens***

102: Bract apex not aristate ..... **P. mitchellii***

81: Stems prostrate or decumbent

103. Inner sepals hairy adaxially

104. Sepal apex acute

105. Plants mat-forming; stems prostrate, persistently stellate-hairy ..... **P. roei**

105: Plants not mat-forming; stems decumbent or erect, glabrous or glabrescent

106. Staminal cup appendages present ..... **P. drummondii***

106: Staminal cup appendages absent

107. Sepals conspicuously clawed ..... **P. unguiculatus***

107: Sepals not clawed ..... **P. esquamatus**

104: Sepal apex truncate-serrate

108. Sepals 3.5–4.5 mm long, sparsely silky-hairy abaxially ..... **P. exiliflorus**

108: Sepals 5–7.7 mm long, densely woolly abaxially ..... **P. humilis**

103: Inner sepals glabrous adaxially

109. Ovary villous-woolly at summit ..... **P. aervoides***

109: Ovary glabrous

110. Sepals not clawed

111. Inflorescences ± pedunculate; outer sepals with a rounded apex; inner sepal midrib region 0.5–0.8 mm wide ..... **P. gomphrenoides***

111: Inflorescences sessile; outer sepals acute; inner sepal midrib region 0.2–0.3 mm wide ..... **P. murrayi**

110: Sepals conspicuously clawed

112. Staminal cup appendages present ..... **P. chamaecladus**

112: Staminal cup appendages absent ..... **P. unguiculatus***

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